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PATENT APPLICATION

ATTORNEY DOCKET NO. 200311332-2

IN THE
UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Randy Hoffman et al.

Confirmation No.: 7102

Application No.: 10/763,353

Examiner: MONDT, Johannes P.

Filing Date: January 23, 2004

Group Art Unit: 3663

Title: Semiconductor Device

Mail Stop Appeal Brief-Patents
Commissioner For Patents
PO Box 1450
Alexandria, VA 22313-1450

TRANSMITTAL OF APPEAL BRIEF

Transmitted herewith is the Appeal Brief in this application with respect to the Notice of Appeal filed on September 2, 2008.

☐ The fee for filing this Appeal Brief is \$540.00 (37 CFR 41.20).

☒ No Additional Fee Required.

(complete (a) or (b) as applicable)

The proceedings herein are for a patent application and the provisions of 37 CFR 1.136(a) apply.

☐ (a) Applicant petitions for an extension of time under 37 CFR 1.136 (fees: 37 CFR 1.17(a)-(d)) for the total number of months checked below:

☐ 1st Month
\$130

☐ 2nd Month
\$490

☐ 3rd Month
\$1110

☐ 4th Month
\$1730

☐ The extension fee has already been filed in this application.

☒ (b) Applicant believes that no extension of time is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition and fee for extension of time.

Please charge to Deposit Account 08-2025 the sum of \$ 00 . At any time during the pendency of this application, please charge any fees required or credit any over payment to Deposit Account 08-2025 pursuant to 37 CFR 1.25. Additionally please charge any fees to Deposit Account 08-2025 under 37 CFR 1.16 through 1.21 inclusive, and any other sections in Title 37 of the Code of Federal Regulations that may regulate fees.

Respectfully submitted,

Randy Hoffman et al.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Randy Hoffman et al.
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APPEAL BRIEF

Mail Stop Appeal Brief - Patents
Commissioner for Patents
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Sir:

This is an Appeal Brief under Rule 41.37 appealing the decision of the Primary Examiner dated June 2, 2008 (the “final Office Action” or “Action”). Each of the topics required by Rule 41.37 is presented herewith and is labeled appropriately.

I. Real Party in Interest

The real party in interest is Hewlett-Packard Development Company, LP, a limited partnership established under the laws of the State of Texas and having a principal place of business at 20555 S.H. 249 Houston, TX 77070, U.S.A. (hereinafter "HPDC"). HPDC is a Texas limited partnership and is a wholly-owned affiliate of Hewlett-Packard Company, a Delaware Corporation, headquartered in Palo Alto, CA. The general or managing partner of HPDC is HPQ Holdings, LLC.

II. Related Appeals and Interferences

There are no appeals or interferences related to the present application of which the Appellant is aware.

III. Status of Claims

Claims 1-3, 5, 10, 13, 16-18, 20-25, 27-30, 40-47, 49, 51-53, 56-59, 61-63, and 65-67 were cancelled previously without prejudice or disclaimer. Thus, claims 4, 6-9, 11, 12, 14, 15, 19, 26, 31-39, 48, 50, 54, 55, 60, and 64 are pending in the present application and stand finally rejected. Accordingly, Appellant appeals from the final rejection of claims 4, 6-9, 11, 12, 14, 15, 19, 26, 31-39, 48, 50, 54, 55, 60, and 64, which claims are presented in the Appendix.

IV. Status of Amendments

One amendment has been filed subsequent to the final Office Action of June 2, 2008, from which Appellant takes this appeal. This amendment seeks to correct a simple typographical error in claim 19 to place the application in better condition for appeal.

V. Summary of Claimed Subject Matter

Appellant's independent claims recite the following subject matter.

Claim 4 recites:

A semiconductor device, comprising:

a source electrode (82) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*);

a drain electrode (84) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*);

a channel (92) coupled to the source electrode (82) and the drain electrode (84) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*) and comprised of a ternary compound containing zinc, tin and oxygen, where at least a portion of the channel (92) is formed from a zinc-tin oxide compound having the following stoichiometry: Zn_2SnO_4 (*Appellant's specification, p. 4, lines 1-15*); and

a gate electrode (80) configured to permit application of an electric field to the channel (92) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*).

Claim 19 recites:

A three-port semiconductor device (10), comprising:

a source electrode (82) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*);

a drain electrode (84) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*);

a gate electrode (80) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*); and

means for providing a channel (92) disposed between the source electrode (82) and drain electrode (84) (*Appellant's specification, p. 4, lines 1-15*), the means for providing a channel (92) configured to permit movement of electric charge therethrough, between the source electrode (82) and the gate electrode (80) in response to a voltage applied at the gate

electrode (80) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*), the means for providing a channel (92) formed at least in part from a ternary compound containing zinc, tin and oxygen (*Appellant's specification, p. 3, lines 19-31*), where the means for providing a channel (92) includes means for providing a semiconductor formed from a zinc-tin oxide compound having the following stoichiometry: Zn_2SnO_4 (*Appellant's specification, p. 4, lines 1-15*).

Claim 48 recites:

A display, comprising:

a plurality of display elements configured to operate collectively to display images, where each of the display elements includes a semiconductor device (10) configured to control light emitted by the display element (*Appellant's specification, p. 4, lines 1-15*), the semiconductor device including:

a source electrode (82) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*);

a drain electrode (84) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*);

a channel (92) coupled to the source electrode (82) and the drain electrode (84) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*) and comprised of a ternary compound containing zinc, tin and oxygen (*Appellant's specification, p. 3, lines 19-31*), where at least a portion of the channel (92) of the semiconductor device (10) is formed from a zinc-tin oxide compound has the following stoichiometry: Zn_2SnO_4 (*Appellant's specification, p. 4, lines 1-15*); and

a gate electrode (80) configured to permit application of an electric field to the channel (*Appellant's specification, p. 5, line 18 to p. 6, line 2*).

Claim 50 recites:

A semiconductor device (10), comprising:

a source electrode (82) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*);

a drain electrode (84) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*);

a channel (92) coupled to the source electrode (82) and the drain electrode (84)

(*Appellant's specification, p. 5, line 18 to p. 6, line 2*) and comprised of a ternary compound containing zinc, tin, and oxygen having the stoichiometry: $(\text{ZnO})_j(\text{SnO}_2)_{1-j}$, where j is between 0.05 and 0.95 (*Appellant's specification, p. 4, lines 1-15*); and

a gate electrode (80) configured to permit application of an electric field to the channel (*Appellant's specification, p. 5, line 18 to p. 6, line 2*).

Claim 60 recites:

A thin-film transistor (10), comprising:

a gate electrode (80) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*);

a channel layer (92) formed from a zinc-tin oxide material having the stoichiometry:

Zn_2SnO_4 (*Appellant's specification, p. 4, lines 1-15*);

a dielectric material (90) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*)

disposed between and separating the gate electrode (80) and the channel layer (92)

(*Appellant's specification, p. 5, line 18 to p. 6, line 2*), and

first and second electrodes (82, 84) spaced from each other and disposed adjacent the channel layer (92) on a side of the channel layer (92) opposite the dielectric material (90) (*Appellant's specification, p. 5, lines 23-26*), such that the channel layer (92) is disposed between and electrically separates the first and second electrodes (82, 84) (*Appellant's specification, p. 5, lines 18-31*);.

Claim 64 recites:

A display (40), comprising:

a plurality of display elements (42) (*Appellant's specification, p. 4, line 23 to p. 5, line 2*) configured to operate collectively to display images, where each of the display elements (42) includes a semiconductor device (10) configured to control light emitted by the display element (42) (*Appellant's specification, p. 4, lines 23-31*), the semiconductor device (10) including:

a source electrode (82) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*);

a drain electrode (84) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*);

a channel (92) coupled to the source electrode (82) and the drain electrode (84) (*Appellant's specification, p. 5, lines 26-28*) and comprised of a ternary compound containing zinc, tin and oxygen having the stoichiometry: Zn_2SnO_4 (*Appellant's specification, p. 4, lines 1-15*); and

a gate electrode (80) configured to permit application of an electric field to the channel (90) (*Appellant's specification, p. 5, line 18 to p. 6, line 2*).

VI. Grounds of Rejection to be Reviewed on Appeal

The final Office Action raised the following grounds of rejection.

(1) Claims 4, 6-9, 11, 26, 31-36, 48, 50, 54, 55, and 60 were rejected under 35 U.S.C. §102(e) as allegedly being anticipated by U.S. Patent App. Pub. No. 2004/0127038 to Carcia et al. (“Carcia”).

(2) Claim 19 was rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over the combined teachings of Carcia and U.S. Patent No. 4,521,698 to Taylor (“Taylor”).

(3) Claim 12 was rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over the combined teachings of Carcia and U.S. Patent No. 6,674,495 to Hong et al. (“Hong”).

(4) Claims 14 and 38 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over the combined teachings of Carcia and U.S. Patent No. (6,100,558) to Krivokapic et al. (“Krivokapic”).

(5) Claims 15 and 39 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over the combined teachings of Carcia, Krivokapic and U.S. Patent App. Pub. No. 2004/0169210 to Hornik et al. (“Hornik”).

(6) Claim 64 was rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over the combined teachings of Carcia and U.S. Patent No. 5,744,864 to Cillessen et al. (“Cillessen”) and U.S. Patent No. (6,184,946) to Ando et al. (“Ando”).

(7) Claims 4, 7-9, 12, 19, 26, 32-35, 37, 48, 50, 54, 55, 60 and 64 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Cillessen.

(8) Claims 6, 11, 31 and 36 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over the combined teachings of Cillessen and Carcia.

According, Appellant hereby requests review of each of these grounds of rejection in the present appeal.

VII. Argument

(1) Claims 4, 6-9, 11, 26, 31-36, 48 and 50, 54, 55, 60 are patentable over Carcia.

Independent claims 4, 48, 50 and 60:

Claim 4 recites:

A semiconductor device, comprising:
 a source electrode;
 a drain electrode;
a channel coupled to the source electrode and the drain electrode and comprised of a ternary compound containing zinc, tin and oxygen, where at least a portion of the channel is formed from a zinc-tin oxide compound having the following stoichiometry: Zn_2SnO_4 ; and
 a gate electrode configured to permit application of an electric field to the channel.

(Emphasis added)

Claim 48 recites:

A display, comprising:
 a plurality of display elements configured to operate collectively to display images, where each of the display elements includes a semiconductor device configured to control light emitted by the display element, the semiconductor device including:
 a source electrode;
 a drain electrode;
a channel coupled to the source electrode and the drain electrode and comprised of a ternary compound containing zinc, tin and oxygen, where at least a portion of the channel of the semiconductor device is formed from a zinc-tin oxide compound has the following stoichiometry: Zn_2SnO_4 ; and
 a gate electrode configured to permit application of an electric field to the channel.

(Emphasis added)

Claim 50 recites:

A semiconductor device, comprising:
 a source electrode;
 a drain electrode;
a channel coupled to the source electrode and the drain electrode and comprised of a ternary compound containing zinc, tin, and oxygen having the stoichiometry: $(ZnO)_j(SnO_2)_{1-j}$, where j is between 0.05 and 0.95; and

a gate electrode configured to permit application of an electric field to the channel.
(Emphasis added)

Claim 60 recites:

A thin-film transistor, comprising:
 a gate electrode;
a channel layer formed from a zinc-tin oxide material having the stoichiometry: Zn_2SnO_4 ;
 a dielectric material disposed between and separating the gate electrode and the channel layer, and
 first and second electrodes spaced from each other and disposed adjacent the channel layer on a side of the channel layer opposite the dielectric material, such that the channel layer is disposed between and electrically separates the first and second electrodes.
 (Emphasis added)

Independent claims 4, 48, 50, and 60 all recite, *inter alia*, a channel which comprises a zinc-tin oxide. The final Office Action, in a §102 rejection, asserts that Carcia, in paragraph 0010, teaches a channel comprised “ternary compound containing zinc, tin and oxygen.”
 (Action, p. 2). Paragraph 0010 of Carcia is reproduced below, in relevant part.

This invention relates to novel, transparent oxide semiconductor (TOS) thin film transistors (TFT's) and the process for their deposition, where the transparent oxide semiconductor (TOS) is selected from the group consisting of zinc oxide (ZnO), indium oxide (In₂O₃), tin oxide (SnO₂), or cadmium oxide (CdO) semiconductor and combinations thereof.

The Action erred in citing paragraph 0010 of Carcia against the present application because the subject matter of paragraph 0010 is not prior art.

The Appellant notes that the present application claims priority to a provisional application, serial number 60/490,239 which was filed on July 25, 2003. Carcia was filed well after that date on Sept. 24, 2003, but claims priority to an earlier provisional application, serial number 60/417,767 (hereinafter “Carcia provisional”) which was filed Oct. 11, 2002.

Consequently, **only subject matter within Carcia that was previously disclosed in the Carcia provisional is available as prior art against the present application.** As it turns out, this excludes paragraph 0010 of Carcia, on which the final Office Action relies, from being prior art.

Apparently, the Examiner has not examined the contents of the Carcia provisional. The Carcia provisional is directed solely toward zinc oxide as a channel material. **The Carcia provisional is absolutely silent with regard to tin, any tin compound, or any combination of zinc oxide with tin.** As a result, Carcia is not a prior art teaching of “a channel layer formed from a zinc-tin oxide material,” as recited in Appellant’s claims. For at least this reason, the rejection of Appellant’s claims based on Carcia cannot be sustained.

Additionally, even if paragraph 0010 of Carcia were prior art against the present application, which it is not, Carcia still does not teach those of skill in the art that zinc-tin oxide is used as channel material. First, Carcia never actually discloses any ternary zinc-tin oxide. The Action asserts that the words “and combinations thereof” in paragraph 0010 teaches that a ternary zinc tin oxide should be used as a channel material. (Action p. 2-3). When paragraph 0010 is understood in the context of the complete disclosure of Carcia, it is clear that Carcia does not teach the use of ternary compounds as transistor channels. Nowhere does Carcia mention, teach, or suggest any ternary compound. Carcia only discloses the use of binary compounds.

Second, one of skill in the art would **not** have understood “and combinations thereof” to include ternary zinc-tin oxide. Ternary compounds, particularly amorphous ternary compounds, were generally assumed by those of skill in the art to have poor electron mobility, rendering them unsuitable for transistor channels. (Appellant’s specification, p. 2).

Appellant found “experimental results revealing a high degree of charge mobility in the present ternary channel material” surprising and “unexpected.” (Appellant’s specification, p.2). Due to the Applicant's duty of candor, the Patent Office is required to give weight to all statements and data in the specification as factual evidence of non-obviousness. *In re Soni* 34 USPQ2d 1684 (Fed. Cir. 1995). Consequently, given the very limited teachings of Carcia, one of ordinary skill in the art would not have understood “and combinations thereof” as teaching that a ternary zinc-tin oxide should be used as a channel material for transparent thin film transistor.

Additionally, the term “and combinations thereof” would not have been interpreted to mean ternary zinc-tin oxide. For example, the term “combination” could include a variety of structural combinations, any number of layers, mixtures, phase segregations, dissolutions, doping, etc., of the previously listed list compounds. Further, the list of compounds disclosed by Carcia includes four types of binary oxides: ZnO, In₂O₃, SnO₂, and CdO. The simple combination of these oxides in all possible combinations would yield six types of ternary oxides, four types of quaternary oxides, and one oxide family that includes all four metals and oxygen. However, none of the 15 compounds resulting from the simple combination of the four disclosed binary compounds would result in the claimed stoichiometry of claims 4, 48 and 60, namely: **Zn₂SnO₄**. This is because the claimed stoichiometry can only be created by adding two zinc oxide molecules to a single tin oxide molecule represented by the following formula: $2\text{ZnO} + \text{SnO}_2 \rightarrow \text{Zn}_2\text{SnO}_4$. Therefore, a simple combination of the compounds disclosed by Carcia would not result in the claimed features.

“A claim is anticipated [under 35 U.S.C. § 102] only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art

reference.” *Verdegaal Bros. v. Union Oil Co. of California*, 2 U.S.P.Q.2d 1051, 1053 (Fed. Cir. 1987). See M.P.E.P. § 2131. In the present case, the subject matter cited by the final Office Action from Carcia is not prior art and therefore cannot be used to show anticipation of Appellant’s claims. Additionally, even if Carcia is considered, it does not teach or suggest the claimed subject matter, specifically ternary zinc-tin oxides used as channel material.

Therefore, for at least the reasons explained here, the rejection based on 35 U.S.C. § 102(b) of claims 4, 48, 50, and 60 and their dependent claims should not be sustained.

Claim 50:

Specifically addressing independent claim 50, which recites, *inter alia*, “a ternary compound containing zinc, tin and oxygen...having the following stoichiometry:

(ZnO)_j(SnO₂)_{1-j}, where j is between 0.05 and 0.95.” This language is directed toward non-stoichiometric compounds that do not correspond to the law of definite proportions. The Action does not address these recited elements but simply asserts that Carcia teaches “a ternary compound containing zinc, tin, and oxygen.” (Action p.6).

Carcia is completely silent with respect to the possibility of creating non-stoichiometric compounds. To the contrary, Carcia discloses only compounds corresponding to the law of definite proportions. Moreover, a compound having the “stoichiometry: (ZnO)_j(SnO₂)_{1-j}, where j is between 0.05 and 0.95” could not be created from the simple mixture of the four binary compounds disclosed by Carcia, because different proportions of the individual components must be combined to create the claimed non-stoichiometric ternary compound.

Therefore, the compound (ZnO)_j(SnO₂)_{1-j}, where j is between 0.05 and 0.95, is not taught by Carcia for at least the reasons set forth above. Again, “[a] claim is anticipated

[under 35 U.S.C. § 102] only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference.” *Verdegaal Bros. v. Union Oil Co. of California*, 2 U.S.P.Q.2d 1051, 1053 (Fed. Cir. 1987). See M.P.E.P. § 2131. Therefore, for at least the additional reasons explained here, the rejection of claim 50 should not be sustained.

(2) Claim 19 is patentable over Carcia and Taylor.

Independent claim 19:

Claim 19 recites:

A three-port semiconductor device, comprising:

a source electrode;

a drain electrode;

a gate electrode; and

means for providing a channel disposed between the source electrode and drain electrode, the means for providing a channel configured to permit movement of electric charge therethrough, between the source electrode and the gate electrode in response to a voltage applied at the gate electrode, *the means for providing a channel formed at least in part from a ternary compound containing zinc, tin and oxygen, where the means for providing a channel includes means for providing a semiconductor formed from a zinc-tin oxide compound having the following stoichiometry: Zn_2SnO_4 .*

(Emphasis added)

Carcia and Taylor fail to teach or suggest the claimed subject matter, specifically, “means for providing a channel formed at least in part from a ternary compound containing zinc, tin and oxygen, where the means for providing a channel includes means for providing a semiconductor formed from a zinc-tin oxide compound having the following stoichiometry: Zn_2SnO_4 .” As discussed above, the cited subject matter within Carcia is not valid art against Appellant’s application. Moreover, as is amply shown above, even if Carcia is considered, it fails to teach or suggest any type of ternary compound containing zinc, tin, and oxygen.

Additionally, nowhere do Carcia or Taylor disclose a “means for providing a semiconductor formed from a zinc-tin oxide compound having the following stoichiometry: Zn_2SnO_4 .” Carcia does not disclose a method, means, or apparatus for chemically combining the elements recited in paragraph 0010 of Carcia to form the claimed “zinc-tin oxide compound having the following stoichiometry: Zn_2SnO_4 .” Taylor fails to cure the deficiencies of Carcia.

Under the analysis required by *Graham v. John Deere*, 383 U.S. 1 (1966) to support a rejection under § 103, the scope and content of the prior art must first be determined, followed by an assessment of the differences between the prior art and the claim at issue in view of the ordinary skill in the art. In the present case, the scope and content of the prior art, does not include the subject matter cited from Carcia. Further even if Carcia is considered, the scope and content of the prior art does not the claimed subject matter, particularly “means for providing a channel formed at least in part from a ternary compound containing zinc, tin and oxygen, where the means for providing a channel includes means for providing a semiconductor formed from a zinc-tin oxide compound having the following stoichiometry: Zn_2SnO_4 .”

The differences between the cited prior art and the claimed subject matter are significant because ternary zinc-tin oxides used as channel layers provide transparency, unexpected electron mobility, high chemical stability, and low cost. Thus, the claimed subject matter provides feature and advantages not known or available in the cited prior art. Consequently, the cited prior art will not support a rejection of claim 19 under 35 U.S.C. § 103 and *Graham*.

(3) Claim 12 is patentable over Carcia and Hong.

The features of independent claim 50, from which claim 12 depends, are not taught or suggested by Carcia, as set forth above. Hong fails to cure the deficiencies of Carcia. Therefore, claim 12 is allowable over Carcia and Hong at least by virtue of its dependence upon allowable claim 50, for the reasons set forth above. Accordingly, withdrawal of this rejection and allowance of claim 12 is respectfully requested.

(4) Claims 14 and 38 are patentable over Carcia and Krivokapic.

The features of independent claim 50, from which claim 14 depends, are not taught or suggested by Carcia, as set forth above. Krivokapic fails to cure the deficiencies of Carcia. Therefore, claim 14 is allowable over Carcia and Krivokapic at least by virtue of its dependence upon allowable claim 50 for the reasons set forth above.

The features of independent claim 60, from which claim 38 depends, are not taught or suggested by Carcia, as set forth above. Krivokapic fails to cure the deficiencies of Carcia. Therefore, claim 38 is allowable over Carcia and Krivokapic at least by virtue of its dependence upon allowable claim 60 for the reasons set forth above.

(5) Claims 15 and 39 are patentable over Carcia, Krivokapic, and Hornik.

Claims 15 and 39 were rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Carcia, Krivokapic, and Hornik.

The features of independent claim 50, from which claim 15 depends, are neither taught nor suggested by Carcia, Krivokapic, or Hornik, taken alone or in combination. Therefore, claim 15 is allowable over the cited art of record, at least, by virtue of its dependence upon allowable claim 50 for the reasons set forth herein.

The features of independent claim 60, from which claim 39 depends, are not taught or suggested by Carcia, as set forth above. Krivokapic fails to cure the deficiencies of Carcia. Therefore, claim 38 is allowable over Carcia and Krivokapic at least by virtue of its dependence upon allowable claim 60 for the reasons set forth above.

(6) Claim 64 is patentable over Carcia, Cillessen, and Ando.

Claim 64 was rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Carcia in view of Cillessen and Ando et al (6,184,946) (“Ando”). This rejection is respectfully traversed because Carcia and Cillessen, taken alone or in combination, fail to teach or suggest the features of independent claim 64. Ando is cited solely to show thin film transistors as switching elements used to control an active matrix display. (Action, p. 16).

Claim 64 recites, *inter alia*, “a ternary compound containing zinc, tin and oxygen having the stoichiometry: Zn_2SnO_4 .” As set forth above, the cited subject matter within Carcia is not available as prior art against Appellant’s application. The remaining references, Cillessen and Ando, together or separately, fail to teach or suggest the subject matter of claim 64.

One of skill in the art would not have understood the disclosures of Cillessen to teach or suggest that ternary zinc-tin oxide be used as a channel material. Ternary compounds, as a class, were generally known to have poor electron mobility, rendering them unsuitable for transistor channels. (Appellant’s specification, p. 2). Appellant found “experimental results revealing a high degree of charge mobility in the present ternary channel material” surprising and “unexpected.” (Appellant’s specification, p.2). Due to the Applicant's duty of candor, the Patent Office is required to give weight to all statements and data in the specification as factual evidence of non-obviousness. *In re Soni*, 34 USPQ2d 1684 (Fed. Cir. 1995).

Consequently, it is clear that using ternary zinc-tin oxide as channel material was against the collective knowledge possessed by those of skill in the art. Thus, one of skill in the art would not have understood “and combinations thereof” as including a ternary zinc-tin oxide.

Ando fails to cure the deficiencies of Cillessen. Specifically, Ando does not disclose or suggest, either separately or in combination with the other cited references “a ternary compound containing zinc, tin and oxygen having the stoichiometry: Zn_2SnO_4 .”

Under the analysis required by *Graham v. John Deere*, 383 U.S. 1 (1966) to support a rejection under § 103, the scope and content of the prior art must first be determined, followed by an assessment of the differences between the prior art and the claim at issue in view of the ordinary skill in the art. In the present case, the scope and content of the prior art, does not include the subject matter cited from Carcia. Further even if Carcia is considered, the scope and content of the prior art, as evidenced by Carcia, Cillessen, and Ando does not the claimed subject matter, particularly “a ternary compound containing zinc, tin and oxygen having the stoichiometry: Zn_2SnO_4 .”

The differences between the cited prior art and the claimed subject matter are significant because ternary zinc-tin oxides used as channel layers provide transparency, unexpected electron mobility, high chemical stability, and low cost. Thus, the claimed subject matter provides feature and advantages not known or available in the cited prior art. Consequently, the cited prior art will not support a rejection of claim 64 under 35 U.S.C. § 103 and *Graham*. Accordingly, withdrawal of this rejection and allowance of claim 64 is respectfully requested.

(7) Claims 4, 7-9, 12, 19, 26, 32-35, 37, 48, 50, 54, 55, 60 and 64 are patentable over Cillessen.

Claims 4, 7-9, 12, 19, 26, 32-35, 37, 48, 50, 54, 55, 60 and 64 were alternatively rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Cillessen. As set forth above, independent claims 4, 19, 48, 60, and 64 recite “a zinc-tin oxide compound having the following stoichiometry: Zn_2SnO_4 ” and independent claim 50 recites “a ternary compound containing zinc, tin, and oxygen having the stoichiometry: $(\text{ZnO})_j(\text{SnO}_2)_{1-j}$, where j is between 0.05 and 0.95.” Cillessen fails to teach or suggest this subject matter.

The Examiner repeatedly refers to the following portion of Cillessen and asserts that this disclosure puts one of skill in the art in possession of the claimed subject matter.

It is also possible to use other covalent oxides of a non-transition metal provided with dopant atoms for the semiconductor material of the channel region 4. Oxides of these metals and mixtures of oxides of these metals have a mobility greater $10 \text{ cm}^2/\text{V}^*\text{s}$ and a bandgap greater than 2.5 eV. For example, Ga_2O_3 , Bi_2O_3 , SnO_2 , ZnO , Sb_2O_3 , PbO , GeO_2 , or In_2O_3 , mixtures of these oxides or compounds formed from these oxides such as GaInO_2 , ZnGa_2O_4 or CdGa_2O_4 may be used.

(Cillessen, col. 5, lines 34-43)

Thus, Cillessen provides a list of eight different binary compounds and states that “mixtures of these oxides or compounds” may be used. (Cillessen, col. 5, lines 34-43). While zinc oxide and tin oxide are included amongst the list of eight different compounds, the number of possible combinations that could be created from the disclosed list is extremely large.

Given the eight different compounds listed by Cillessen $\{\text{Ga}_2\text{O}_3, \text{Bi}_2\text{O}_3, \text{SnO}_2, \text{ZnO}, \text{Sb}_2\text{O}_3, \text{PbO}, \text{GeO}_2, \text{In}_2\text{O}_3\}$ and using the direction of Cillessen that “mixtures of these oxides or compounds formed from these oxides” are to be constructed, the number of unique materials (UM) can be estimated using the formula:

$$UM = \frac{(n + r - 1)!}{r!(n - 1)!} \quad \text{Eq. 1}$$

Where: n = the number of compounds to be selected from among, namely the eight compounds disclosed by Cillessen, {Ga₂O₃, Bi₂O₃, SnO₂, ZnO, Sb₂O₃, PbO, GeO₂, In₂O₃}
 r = the number to be chosen from among the eight compounds. For example, for a binary compound, two of the disclosed compounds are selected; for a ternary compound three of the disclosed compounds are selected; for a quaternary compound four of the disclosed compounds are selected, and so forth.

Equation 1 allows for repetition in the selection of the r compounds. This is necessary to allow the creation of the claimed compound, Zn₂SnO₄, which requires the repetitive selection of two ZnO molecules to be combined with one SnO₂ molecule. Equation 1 does not allow for order distinctions to artificially inflate the number of compounds. For example, Equation 1 does not generate non-unique compounds such as both (ZnO SnO₂ SnO₂) and (SnO₂ SnO₂ ZnO). Rather, Equation 1 recognizes that the listing order of the molecules is not important and will only generate one unique compound which contains two SnO₂ molecules and one ZnO. Thus, each and every compound that is generated by Equation 1 is unique within the class of compounds. For purposes of illustration, the Appellant will limit the example to forming binary, ternary and quaternary compounds, although Cillessen does not provide one of ordinary skill with the benefit of any such limitation. These unique compounds are listed below by class, namely binary compounds consisting of unique combinations of two of the eight disclosed compounds, ternary compounds consisting of unique combinations of three of the eight disclosed compounds and quaternary compounds consisting of unique combinations of four of the eight disclosed compounds.

Binary Compounds: 36

{Ga₂O₃, Ga₂O₃} {Ga₂O₃, Bi₂O₃} {Ga₂O₃, SnO₂} {Ga₂O₃, ZnO} {Ga₂O₃, Sb₂O₃}
 {Ga₂O₃, PbO} {Ga₂O₃, GeO₂} {Ga₂O₃, In₂O₃} {Bi₂O₃, Bi₂O₃} {Bi₂O₃, SnO₂} {Bi₂O₃,
 ZnO} {Bi₂O₃, Sb₂O₃} {Bi₂O₃, PbO} {Bi₂O₃, GeO₂} {Bi₂O₃, In₂O₃} {SnO₂, SnO₂} {
 SnO₂, ZnO} {SnO₂, Sb₂O₃} {SnO₂, PbO} {SnO₂, GeO₂} {SnO₂, In₂O₃} {ZnO, ZnO} {
 ZnO, Sb₂O₃} {ZnO, PbO} {ZnO, GeO₂} {ZnO, In₂O₃} {Sb₂O₃, Sb₂O₃} {Sb₂O₃, PbO} {
 Sb₂O₃, GeO₂} {Sb₂O₃, In₂O₃} {PbO, PbO} {PbO, GeO₂} {PbO, In₂O₃} {GeO₂, GeO₂} {
 GeO₂, In₂O₃} {In₂O₃, In₂O₃}

Ternary Compounds: 120

{Ga₂O₃, Ga₂O₃, Ga₂O₃} {Ga₂O₃, Ga₂O₃, Bi₂O₃} {Ga₂O₃, Ga₂O₃, SnO₂}
 {Ga₂O₃, Ga₂O₃, ZnO} {Ga₂O₃, Ga₂O₃, Sb₂O₃} {Ga₂O₃, Ga₂O₃, PbO} {Ga₂O₃, Ga₂O₃, GeO₂}
 {Ga₂O₃, Ga₂O₃, In₂O₃} {Ga₂O₃, Bi₂O₃, Bi₂O₃} {Ga₂O₃, Bi₂O₃, SnO₂} {Ga₂O₃, Bi₂O₃,
 ZnO} {Ga₂O₃, Bi₂O₃, Sb₂O₃} {Ga₂O₃, Bi₂O₃, PbO} {Ga₂O₃, Bi₂O₃, GeO₂} {Ga₂O₃, Bi₂O₃,
 In₂O₃} {Ga₂O₃, SnO₂, SnO₂} {Ga₂O₃, SnO₂, ZnO} {Ga₂O₃, SnO₂, Sb₂O₃} {Ga₂O₃, SnO₂,
 PbO} {Ga₂O₃, SnO₂, GeO₂} {Ga₂O₃, SnO₂, In₂O₃} {Ga₂O₃, ZnO, ZnO} {Ga₂O₃, ZnO,
 Sb₂O₃} {Ga₂O₃, ZnO, PbO} {Ga₂O₃, ZnO, GeO₂} {Ga₂O₃, ZnO, In₂O₃} {Ga₂O₃, Sb₂O₃,
 Sb₂O₃} {Ga₂O₃, Sb₂O₃, PbO} {Ga₂O₃, Sb₂O₃, GeO₂} {Ga₂O₃, Sb₂O₃, In₂O₃} {Ga₂O₃,
 PbO, PbO} {Ga₂O₃, PbO, GeO₂} {Ga₂O₃, PbO, In₂O₃} {Ga₂O₃, GeO₂, GeO₂} {Ga₂O₃,
 GeO₂, In₂O₃} {Ga₂O₃, In₂O₃, In₂O₃} {Bi₂O₃, Bi₂O₃, Bi₂O₃} {Bi₂O₃, Bi₂O₃, SnO₂} {
 Bi₂O₃, Bi₂O₃, ZnO} {Bi₂O₃, Bi₂O₃, Sb₂O₃} {Bi₂O₃, Bi₂O₃, PbO} {Bi₂O₃, Bi₂O₃, GeO₂} {
 Bi₂O₃, Bi₂O₃, In₂O₃} {Bi₂O₃, SnO₂, SnO₂} {Bi₂O₃, SnO₂, ZnO} {Bi₂O₃, SnO₂, Sb₂O₃} {
 Bi₂O₃, SnO₂, PbO} {Bi₂O₃, SnO₂, GeO₂} {Bi₂O₃, SnO₂, In₂O₃} {Bi₂O₃, ZnO, ZnO} {
 Bi₂O₃, ZnO, Sb₂O₃} {Bi₂O₃, ZnO, PbO} {Bi₂O₃, ZnO, GeO₂} {Bi₂O₃, ZnO, In₂O₃} {

Bi2O3, Sb2O3, Sb2O3} { Bi2O3, Sb2O3, PbO} { Bi2O3, Sb2O3, GeO2} { Bi2O3, Sb2O3, In2O3} { Bi2O3, PbO, PbO} { Bi2O3, PbO, GeO2} { Bi2O3, PbO, In2O3} { Bi2O3, GeO2, GeO2} { Bi2O3, GeO2, In2O3} { Bi2O3, In2O3, In2O3} { SnO2, SnO2, SnO2} { SnO2, SnO2, ZnO} { SnO2, SnO2, Sb2O3} { SnO2, SnO2, PbO} { SnO2, SnO2, GeO2} { SnO2, SnO2, In2O3} { **SnO2, ZnO, ZnO**} { SnO2, ZnO, Sb2O3} { SnO2, ZnO, PbO} { SnO2, ZnO, GeO2} { SnO2, ZnO, In2O3} { SnO2, Sb2O3, Sb2O3} { SnO2, Sb2O3, PbO} { SnO2, Sb2O3, GeO2} { SnO2, Sb2O3, In2O3} { SnO2, PbO, PbO} { SnO2, PbO, GeO2} { SnO2, PbO, In2O3} { SnO2, GeO2, GeO2} { SnO2, GeO2, In2O3} { SnO2, In2O3, In2O3} { ZnO, ZnO, ZnO} { ZnO, ZnO, Sb2O3} { ZnO, ZnO, PbO} { ZnO, ZnO, GeO2} { ZnO, ZnO, In2O3} { ZnO, Sb2O3, Sb2O3} { ZnO, Sb2O3, PbO} { ZnO, Sb2O3, GeO2} { ZnO, Sb2O3, In2O3} { ZnO, PbO, PbO} { ZnO, PbO, GeO2} { ZnO, PbO, In2O3} { ZnO, GeO2, GeO2} { ZnO, GeO2, In2O3} { ZnO, In2O3, In2O3} { Sb2O3, Sb2O3, Sb2O3} { Sb2O3, Sb2O3, PbO} { Sb2O3, Sb2O3, GeO2} { Sb2O3, Sb2O3, In2O3} { Sb2O3, PbO, PbO} { Sb2O3, PbO, GeO2} { Sb2O3, PbO, In2O3} { Sb2O3, GeO2, GeO2} { Sb2O3, GeO2, In2O3} { Sb2O3, In2O3, In2O3} { PbO, PbO, PbO} { PbO, PbO, GeO2} { PbO, PbO, In2O3} { PbO, GeO2, GeO2} { PbO, GeO2, In2O3} { PbO, In2O3, In2O3} { GeO2, GeO2, GeO2} { GeO2, GeO2, In2O3} { GeO2, In2O3, In2O3} { In2O3, In2O3, In2O3}.

Quadrinary Compounds:330

{Ga2O3, Ga2O3, Ga2O3, Ga2O3} {Ga2O3, Ga2O3, Ga2O3, Bi2O3} {Ga2O3, Ga2O3, Ga2O3, SnO2} {Ga2O3, Ga2O3, Ga2O3, ZnO} {Ga2O3, Ga2O3, Ga2O3, Sb2O3} {Ga2O3, Ga2O3, Ga2O3, PbO} {Ga2O3, Ga2O3, Ga2O3, GeO2} {Ga2O3, Ga2O3, Ga2O3, In2O3} {Ga2O3, Ga2O3, Bi2O3, Bi2O3} {Ga2O3, Ga2O3, Bi2O3, SnO2} {Ga2O3, Ga2O3, Bi2O3, ZnO} {Ga2O3, Ga2O3, Bi2O3, Sb2O3} {Ga2O3, Ga2O3, Bi2O3, PbO} {Ga2O3, Ga2O3, Bi2O3, GeO2} {Ga2O3, Ga2O3, Bi2O3,

In2O3} {Ga203,Ga203, Sn02, Sn02} {Ga203,Ga203, Sn02, ZnO} {Ga203,Ga203, Sn02, Sb203} {Ga203,Ga203, Sn02, PbO} {Ga203,Ga203, Sn02, Ge02} {Ga203,Ga203, Sn02, In2O3} {Ga203,Ga203, ZnO, ZnO} {Ga203,Ga203, ZnO, Sb203} {Ga203,Ga203, ZnO, PbO} {Ga203,Ga203, ZnO, Ge02} {Ga203,Ga203, ZnO, In2O3} {Ga203,Ga203, Sb203, Sb203} {Ga203,Ga203, Sb203, PbO} {Ga203,Ga203, Sb203, Ge02} {Ga203,Ga203, Sb203, In2O3} {Ga203,Ga203, PbO, PbO} {Ga203,Ga203, PbO, Ge02} {Ga203,Ga203, PbO, In2O3} {Ga203,Ga203, Ge02, Ge02} {Ga203,Ga203, Ge02, In2O3} {Ga203,Ga203, In2O3, In2O3} {Ga203, Bi203, Bi203, Bi203} {Ga203, Bi203, Bi203, Sn02} {Ga203, Bi203, Bi203, ZnO} {Ga203, Bi203, Bi203, Sb203} {Ga203, Bi203, Bi203, PbO} {Ga203, Bi203, Bi203, Ge02} {Ga203, Bi203, Bi203, In2O3} {Ga203, Bi203, Sn02, Sn02} {Ga203, Bi203, Sn02, ZnO} {Ga203, Bi203, Sn02, Sb203} {Ga203, Bi203, Sn02, PbO} {Ga203, Bi203, Sn02, Ge02} {Ga203, Bi203, Sn02, In2O3} {Ga203, Bi203, ZnO, ZnO} {Ga203, Bi203, ZnO, Sb203} {Ga203, Bi203, ZnO, PbO} {Ga203, Bi203, ZnO, Ge02} {Ga203, Bi203, ZnO, In2O3} {Ga203, Bi203, Sb203, Sb203} {Ga203, Bi203, Sb203, PbO} {Ga203, Bi203, Sb203, Ge02} {Ga203, Bi203, Sb203, In2O3} {Ga203, Bi203, PbO, PbO} {Ga203, Bi203, PbO, Ge02} {Ga203, Bi203, PbO, In2O3} {Ga203, Bi203, Ge02, Ge02} {Ga203, Bi203, Ge02, In2O3} {Ga203, Bi203, In2O3, In2O3} {Ga203, Sn02, Sn02, Sn02} {Ga203, Sn02, Sn02, ZnO} {Ga203, Sn02, Sn02, Sb203} {Ga203, Sn02, Sn02, PbO} {Ga203, Sn02, Sn02, Ge02} {Ga203, Sn02, Sn02, In2O3} {Ga203, Sn02, ZnO, ZnO} {Ga203, Sn02, ZnO, Sb203} {Ga203, Sn02, ZnO, PbO} {Ga203, Sn02, ZnO, Ge02} {Ga203, Sn02, ZnO, In2O3} {Ga203, Sn02, Sb203, Sb203} {Ga203, Sn02, Sb203, PbO} {Ga203, Sn02, Sb203, Ge02} {Ga203, Sn02, Sb203, In2O3} {Ga203, Sn02, PbO, PbO} {Ga203, Sn02, PbO, Ge02} {Ga203, Sn02, PbO, In2O3} {Ga203, Sn02, Ge02, Ge02} {Ga203, Sn02, Ge02, In2O3} {Ga203, Sn02, In2O3, In2O3} {Ga203, ZnO, ZnO, ZnO} {Ga203, ZnO, ZnO, Sb203} {Ga203, ZnO, ZnO, PbO, In2O3}

PbO} {Ga2O3, ZnO, ZnO, GeO2} {Ga2O3, ZnO, ZnO, In2O3} {Ga2O3, ZnO, Sb2O3, Sb2O3}
 {Ga2O3, ZnO, Sb2O3, PbO} {Ga2O3, ZnO, Sb2O3, GeO2} {Ga2O3, ZnO, Sb2O3, In2O3}
 {Ga2O3, ZnO, PbO, PbO} {Ga2O3, ZnO, PbO, GeO2} {Ga2O3, ZnO, PbO, In2O3} {Ga2O3,
 ZnO, GeO2, GeO2} {Ga2O3, ZnO, GeO2, In2O3} {Ga2O3, ZnO, In2O3, In2O3} {Ga2O3,
 Sb2O3, Sb2O3, Sb2O3} {Ga2O3, Sb2O3, Sb2O3, PbO} {Ga2O3, Sb2O3, Sb2O3, GeO2}
 {Ga2O3, Sb2O3, Sb2O3, In2O3} {Ga2O3, Sb2O3, PbO, PbO} {Ga2O3, Sb2O3, PbO, GeO2}
 {Ga2O3, Sb2O3, PbO, In2O3} {Ga2O3, Sb2O3, GeO2, GeO2} {Ga2O3, Sb2O3, GeO2, In2O3}
 {Ga2O3, Sb2O3, In2O3, In2O3} {Ga2O3, PbO, PbO, PbO} {Ga2O3, PbO, PbO, GeO2}
 {Ga2O3, PbO, PbO, In2O3} {Ga2O3, PbO, GeO2, GeO2} {Ga2O3, PbO, GeO2, In2O3}
 {Ga2O3, PbO, In2O3, In2O3} {Ga2O3, GeO2, GeO2, GeO2} {Ga2O3, GeO2, GeO2, In2O3}
 {Ga2O3, GeO2, In2O3, In2O3} {Ga2O3, In2O3, In2O3, In2O3} { Bi2O3, Bi2O3, Bi2O3,
 Bi2O3} { Bi2O3, Bi2O3, Bi2O3, SnO2} { Bi2O3, Bi2O3, Bi2O3, ZnO} { Bi2O3, Bi2O3, Bi2O3,
 Sb2O3} { Bi2O3, Bi2O3, Bi2O3, PbO} { Bi2O3, Bi2O3, Bi2O3, GeO2} { Bi2O3, Bi2O3, Bi2O3,
 In2O3} { Bi2O3, Bi2O3, SnO2, SnO2} { Bi2O3, Bi2O3, SnO2, ZnO} { Bi2O3, Bi2O3, SnO2,
 Sb2O3} { Bi2O3, Bi2O3, SnO2, PbO} { Bi2O3, Bi2O3, SnO2, GeO2} { Bi2O3, Bi2O3, SnO2,
 In2O3} { Bi2O3, Bi2O3, ZnO, ZnO} { Bi2O3, Bi2O3, ZnO, Sb2O3} { Bi2O3, Bi2O3, ZnO,
 PbO} { Bi2O3, Bi2O3, ZnO, GeO2} { Bi2O3, Bi2O3, ZnO, In2O3} { Bi2O3, Bi2O3, Sb2O3,
 Sb2O3} { Bi2O3, Bi2O3, Sb2O3, PbO} { Bi2O3, Bi2O3, Sb2O3, GeO2} { Bi2O3, Bi2O3, Sb2O3,
 In2O3} { Bi2O3, Bi2O3, PbO, PbO} { Bi2O3, Bi2O3, PbO, GeO2} { Bi2O3, Bi2O3, PbO,
 In2O3} { Bi2O3, Bi2O3, GeO2, GeO2} { Bi2O3, Bi2O3, GeO2, In2O3} { Bi2O3, Bi2O3, In2O3,
 In2O3} { Bi2O3, SnO2, SnO2, SnO2} { Bi2O3, SnO2, SnO2, ZnO} { Bi2O3, SnO2, SnO2,
 Sb2O3} { Bi2O3, SnO2, SnO2, PbO} { Bi2O3, SnO2, SnO2, GeO2} { Bi2O3, SnO2, SnO2,
 In2O3} { Bi2O3, SnO2, ZnO, ZnO} { Bi2O3, SnO2, ZnO, Sb2O3} { Bi2O3, SnO2, ZnO, PbO}
 { Bi2O3, SnO2, ZnO, GeO2} { Bi2O3, SnO2, ZnO, In2O3} { Bi2O3, SnO2, Sb2O3, Sb2O3} {

Bi2O3, SnO2, Sb2O3, PbO} { Bi2O3, SnO2, Sb2O3, GeO2} { Bi2O3, SnO2, Sb2O3, In2O3} {
 Bi2O3, SnO2, PbO, PbO} { Bi2O3, SnO2, PbO, GeO2} { Bi2O3, SnO2, PbO, In2O3} { Bi2O3,
 SnO2, GeO2, GeO2} { Bi2O3, SnO2, GeO2, In2O3} { Bi2O3, SnO2, In2O3, In2O3} { Bi2O3,
 ZnO, ZnO, ZnO} { Bi2O3, ZnO, ZnO, Sb2O3} { Bi2O3, ZnO, ZnO, PbO} { Bi2O3, ZnO,
 ZnO, GeO2} { Bi2O3, ZnO, ZnO, In2O3} { Bi2O3, ZnO, Sb2O3, Sb2O3} { Bi2O3, ZnO,
 Sb2O3, PbO} { Bi2O3, ZnO, Sb2O3, GeO2} { Bi2O3, ZnO, Sb2O3, In2O3} { Bi2O3, ZnO,
 PbO, PbO} { Bi2O3, ZnO, PbO, GeO2} { Bi2O3, ZnO, PbO, In2O3} { Bi2O3, ZnO, GeO2,
 GeO2} { Bi2O3, ZnO, GeO2, In2O3} { Bi2O3, ZnO, In2O3, In2O3} { Bi2O3, Sb2O3, Sb2O3,
 Sb2O3} { Bi2O3, Sb2O3, Sb2O3, PbO} { Bi2O3, Sb2O3, Sb2O3, GeO2} { Bi2O3, Sb2O3,
 Sb2O3, In2O3} { Bi2O3, Sb2O3, PbO, PbO} { Bi2O3, Sb2O3, PbO, GeO2} { Bi2O3, Sb2O3,
 PbO, In2O3} { Bi2O3, Sb2O3, GeO2, GeO2} { Bi2O3, Sb2O3, GeO2, In2O3} { Bi2O3, Sb2O3,
 In2O3, In2O3} { Bi2O3, PbO, PbO, PbO} { Bi2O3, PbO, PbO, GeO2} { Bi2O3, PbO, PbO,
 In2O3} { Bi2O3, PbO, GeO2, GeO2} { Bi2O3, PbO, GeO2, In2O3} { Bi2O3, PbO, In2O3,
 In2O3} { Bi2O3, GeO2, GeO2, GeO2} { Bi2O3, GeO2, GeO2, In2O3} { Bi2O3, GeO2, In2O3,
 In2O3} { Bi2O3, In2O3, In2O3, In2O3} { SnO2, SnO2, SnO2, SnO2} { SnO2, SnO2, SnO2,
 ZnO} { SnO2, SnO2, SnO2, Sb2O3} { SnO2, SnO2, SnO2, PbO} { SnO2, SnO2, SnO2, GeO2} {
 SnO2, SnO2, SnO2, In2O3} { SnO2, SnO2, ZnO, ZnO} { SnO2, SnO2, ZnO, Sb2O3} { SnO2,
 SnO2, ZnO, PbO} { SnO2, SnO2, ZnO, GeO2} { SnO2, SnO2, ZnO, In2O3} { SnO2, SnO2,
 Sb2O3, Sb2O3} { SnO2, SnO2, Sb2O3, PbO} { SnO2, SnO2, Sb2O3, GeO2} { SnO2, SnO2,
 Sb2O3, In2O3} { SnO2, SnO2, PbO, PbO} { SnO2, SnO2, PbO, GeO2} { SnO2, SnO2, PbO,
 In2O3} { SnO2, SnO2, GeO2, GeO2} { SnO2, SnO2, GeO2, In2O3} { SnO2, SnO2, In2O3,
 In2O3} { SnO2, ZnO, ZnO, ZnO} { SnO2, ZnO, ZnO, Sb2O3} { SnO2, ZnO, ZnO, PbO} {
 SnO2, ZnO, ZnO, GeO2} { SnO2, ZnO, ZnO, In2O3} { SnO2, ZnO, Sb2O3, Sb2O3} { SnO2,
 ZnO, Sb2O3, PbO} { SnO2, ZnO, Sb2O3, GeO2} { SnO2, ZnO, Sb2O3, In2O3} { SnO2, ZnO,

PbO, PbO} { SnO₂, ZnO, PbO, GeO₂} { SnO₂, ZnO, PbO, In₂O₃} { SnO₂, ZnO, GeO₂, GeO₂} { SnO₂, ZnO, GeO₂, In₂O₃} { SnO₂, ZnO, In₂O₃, In₂O₃} { SnO₂, Sb₂O₃, Sb₂O₃, Sb₂O₃} { SnO₂, Sb₂O₃, Sb₂O₃, PbO} { SnO₂, Sb₂O₃, Sb₂O₃, GeO₂} { SnO₂, Sb₂O₃, Sb₂O₃, In₂O₃} { SnO₂, Sb₂O₃, PbO, PbO} { SnO₂, Sb₂O₃, PbO, GeO₂} { SnO₂, Sb₂O₃, PbO, In₂O₃} { SnO₂, Sb₂O₃, GeO₂, GeO₂} { SnO₂, Sb₂O₃, GeO₂, In₂O₃} { SnO₂, Sb₂O₃, In₂O₃, In₂O₃} { SnO₂, PbO, PbO, PbO} { SnO₂, PbO, PbO, GeO₂} { SnO₂, PbO, PbO, In₂O₃} { SnO₂, PbO, GeO₂, GeO₂} { SnO₂, PbO, GeO₂, In₂O₃} { SnO₂, PbO, In₂O₃, In₂O₃} { SnO₂, GeO₂, GeO₂, GeO₂} { SnO₂, GeO₂, GeO₂, In₂O₃} { SnO₂, GeO₂, In₂O₃, In₂O₃} { SnO₂, In₂O₃, In₂O₃, In₂O₃} { ZnO, ZnO, ZnO, ZnO} { ZnO, ZnO, ZnO, Sb₂O₃} { ZnO, ZnO, ZnO, PbO} { ZnO, ZnO, ZnO, GeO₂} { ZnO, ZnO, ZnO, In₂O₃} { ZnO, ZnO, Sb₂O₃, Sb₂O₃} { ZnO, ZnO, Sb₂O₃, PbO} { ZnO, ZnO, Sb₂O₃, GeO₂} { ZnO, ZnO, Sb₂O₃, In₂O₃} { ZnO, ZnO, PbO, PbO} { ZnO, ZnO, PbO, GeO₂} { ZnO, ZnO, PbO, In₂O₃} { ZnO, ZnO, GeO₂, GeO₂} { ZnO, ZnO, GeO₂, In₂O₃} { ZnO, ZnO, In₂O₃, In₂O₃} { ZnO, Sb₂O₃, Sb₂O₃, Sb₂O₃} { ZnO, Sb₂O₃, Sb₂O₃, PbO} { ZnO, Sb₂O₃, Sb₂O₃, GeO₂} { ZnO, Sb₂O₃, Sb₂O₃, In₂O₃} { ZnO, Sb₂O₃, PbO, PbO} { ZnO, Sb₂O₃, PbO, GeO₂} { ZnO, Sb₂O₃, PbO, In₂O₃} { ZnO, Sb₂O₃, GeO₂, GeO₂} { ZnO, Sb₂O₃, GeO₂, In₂O₃} { ZnO, Sb₂O₃, In₂O₃, In₂O₃} { ZnO, PbO, PbO, PbO} { ZnO, PbO, PbO, GeO₂} { ZnO, PbO, PbO, In₂O₃} { ZnO, PbO, GeO₂, GeO₂} { ZnO, PbO, GeO₂, In₂O₃} { ZnO, PbO, In₂O₃, In₂O₃} { ZnO, GeO₂, GeO₂, GeO₂} { ZnO, GeO₂, GeO₂, In₂O₃} { ZnO, GeO₂, In₂O₃, In₂O₃} { ZnO, In₂O₃, In₂O₃, In₂O₃} { Sb₂O₃, Sb₂O₃, Sb₂O₃, Sb₂O₃} { Sb₂O₃, Sb₂O₃, Sb₂O₃, PbO} { Sb₂O₃, Sb₂O₃, Sb₂O₃, GeO₂} { Sb₂O₃, Sb₂O₃, Sb₂O₃, In₂O₃} { Sb₂O₃, Sb₂O₃, PbO, PbO} { Sb₂O₃, Sb₂O₃, PbO, GeO₂} { Sb₂O₃, Sb₂O₃, PbO, In₂O₃} { Sb₂O₃, Sb₂O₃, GeO₂, GeO₂} { Sb₂O₃, Sb₂O₃, GeO₂, In₂O₃} { Sb₂O₃, Sb₂O₃, In₂O₃, In₂O₃} { Sb₂O₃, PbO, PbO, PbO} { Sb₂O₃, PbO, PbO, GeO₂} { Sb₂O₃, PbO, PbO, In₂O₃} { Sb₂O₃, PbO, GeO₂, GeO₂} { Sb₂O₃, PbO, GeO₂, In₂O₃} { Sb₂O₃, PbO, In₂O₃, In₂O₃}

$\text{In}_2\text{O}_3, \text{In}_2\text{O}_3\} \{ \text{Sb}_2\text{O}_3, \text{GeO}_2, \text{GeO}_2, \text{GeO}_2\} \{ \text{Sb}_2\text{O}_3, \text{GeO}_2, \text{GeO}_2, \text{In}_2\text{O}_3\} \{ \text{Sb}_2\text{O}_3, \text{GeO}_2, \text{In}_2\text{O}_3, \text{In}_2\text{O}_3\} \{ \text{Sb}_2\text{O}_3, \text{In}_2\text{O}_3, \text{In}_2\text{O}_3, \text{In}_2\text{O}_3\} \{ \text{PbO}, \text{PbO}, \text{PbO}, \text{PbO}\} \{ \text{PbO}, \text{PbO}, \text{PbO}, \text{GeO}_2\} \{ \text{PbO}, \text{PbO}, \text{PbO}, \text{In}_2\text{O}_3\} \{ \text{PbO}, \text{PbO}, \text{GeO}_2, \text{GeO}_2\} \{ \text{PbO}, \text{PbO}, \text{GeO}_2, \text{In}_2\text{O}_3\} \{ \text{PbO}, \text{PbO}, \text{In}_2\text{O}_3, \text{In}_2\text{O}_3\} \{ \text{PbO}, \text{GeO}_2, \text{GeO}_2, \text{GeO}_2\} \{ \text{PbO}, \text{GeO}_2, \text{GeO}_2, \text{In}_2\text{O}_3\} \{ \text{PbO}, \text{GeO}_2, \text{In}_2\text{O}_3, \text{In}_2\text{O}_3\} \{ \text{PbO}, \text{In}_2\text{O}_3, \text{In}_2\text{O}_3, \text{In}_2\text{O}_3\} \{ \text{GeO}_2, \text{GeO}_2, \text{GeO}_2, \text{GeO}_2\} \{ \text{GeO}_2, \text{GeO}_2, \text{GeO}_2, \text{In}_2\text{O}_3\} \{ \text{GeO}_2, \text{GeO}_2, \text{In}_2\text{O}_3, \text{In}_2\text{O}_3\} \{ \text{GeO}_2, \text{In}_2\text{O}_3, \text{In}_2\text{O}_3, \text{In}_2\text{O}_3\} \{ \text{In}_2\text{O}_3, \text{In}_2\text{O}_3, \text{In}_2\text{O}_3, \text{In}_2\text{O}_3\}$

Only one of the above is the recited compound of claims 4, 19, 48, 60, and 64 namely, Zn_2SnO_4 . For the convenience of the reader, the claimed compound is highlighted. However, Cillessen does not provide one of ordinary skill in the art the benefit of a highlighted formula within the 486 unique combinations described above. Additionally, Cillessen does not limit its disclosure to “compounds” of the disclosed list of materials, but also includes “mixtures.” Thus, each of the disclosed unique sets above could be, alternatively, “mixtures” of these oxides. Consequently, Cillessen leaves one of skill in the art to analyze, manufacture, and test 486 compounds and 486 mixtures. Additionally, the possibility remains open for the combination of two or more compounds, two or more mixtures, or one or more compounds with one or more mixtures. For example, Cillessen discloses Sb-doped SnO_2 and Sn-doped In_2O_3 . Further, the compounds or mixtures could be combined of various geometries, including layers, columns, solutions, phase segregations, etc.

The fact that there are a number of combinations which do not form chemical bonds due to molecular bonding constraints (as pointed out by the Examiner, Action, p. 22) only complicates the inquiry by including inoperable embodiments. Further, a large number of the compounds, although chemically viable, may not have the performance characteristics desired to operate as a thin film transistor channel. This low likelihood of success, combined with

the overwhelming number of “mixtures of these oxides” and “compounds formed from these oxides” does not teach or suggest to one of skill in the art that Zn_2SnO_4 should be selected and is suitable for a channel in a transparent thin film transistor.

The Official Action states that “the claim would have been obvious because one of ordinary skill has good reason to pursue the known options within his or her technical grasp; if this leads to the anticipated success, it is likely the product not of innovation but of ordinary skill and common sense.” (Action, on each of pages 13, 15-19). The Appellants note that, not only is the claimed stoichiometry not taught or suggested, but Cillessen also fails to mention, teach, or suggest any combination containing zinc-tin oxide. The rejection attempts to compensate for the deficiencies in the cited art with a naked allegation that arriving at the claimed features from the almost 1000 “compounds” and “mixtures” would have been obvious. This position strains credibility.

Pursuing every possible option available to a person having ordinary skill in the art would involve near-endless creating, implementing, testing, analyzing, re-testing, etc. Repeating this process for every possible chemical compound would be, if not impossible, prohibitively labor-intensive, time-consuming, wasteful, and expensive. Therefore, the experimental creation and testing of different compounds may, at first glance, seem scientifically desirable; however, “pursuing” every possible compound is forbidden by real-world practicability limitations.

The final Office Action does not attempt to provide any reasons why a person having ordinary skill in the art would attempt to make a zinc-tin oxide combination or attempt to combine zinc, tin, and oxygen in the asymmetric proportions necessary to create the claimed stoichiometry based on the teachings of Cillessen. By the logic proffered in the rejection, the creation and use of almost any compound in almost any application would have been obvious.

Moreover, the final Office Action provides no evidence that the claimed zinc-tin oxide ternary compound and the claimed stoichiometry is a “**known**” option. In fact, the evidence contradicts this assertion, because both Carcia and Cillessen, like the remaining prior art of record, fail to teach or suggest a zinc-tin oxide ternary compound.

MPEP § 2121.01 states:

“In determining that quantum of prior art disclosure which is necessary to declare an applicant's invention 'not novel' or 'anticipated' within section 102, the stated test is whether a reference contains an 'enabling disclosure'... ." *In re Hoeksema*, 399 F.2d 269, 158 USPQ 596 (CCPA 1968). The disclosure in an assertedly anticipating reference must provide an enabling disclosure of the desired subject matter; mere naming or description of the subject matter is insufficient, if it cannot be produced without undue experimentation. *Elan Pharm., Inc. v. Mayo Found. For Med. Educ. & Research*, 346 F.3d 1051, 1054, 68 USPQ2d 1373, 1376 (Fed. Cir. 2003) A reference contains an "enabling disclosure" if the public was in possession of the claimed invention before the date of invention. "Such possession is effected if one of ordinary skill in the art could have combined the publication's description of the invention with his [or her] own knowledge to make the claimed invention." *In re Donohue*, 766 F.2d 531, 226 USPQ 619 (Fed. Cir. 1985).

Clearly, as demonstrated above, the cited prior art did not enable the claimed invention or place those skilled in the art in possession of the invention, without undue experimentation.

Moreover, as mentioned above, the claimed invention is contrary to the generally accepted wisdom in the art. Ternary compounds, particularly amorphous ternary compounds, were generally understood to have poor electron mobility, rendering them unsuitable for transistor channels. (Appellant’s specification, p. 2). Appellants note that the originally filed specification clearly teaches that the discovered zinc-tin oxide combination provides unexpected results. Appellant found “**experimental results** revealing a high degree of charge mobility in the present ternary channel material” surprising and “**unexpected.**” (Appellant’s specification, p.2). Due to the Applicant's duty of candor, the Patent Office is required to give

weight to all statements and data in the specification as factual evidence of non-obviousness.

In re Soni, 34 USPQ2d 1684 (Fed. Cir. 1995).

The MPEP states that "A greater than expected result is an evidentiary factor pertinent to the legal conclusion of obviousness ... of the claims at issue." *In re Corkill*, 711 F.2d 1496, 226 USPQ 1005 (Fed. Cir. 1985) (MPEP 716.02(a)). Here, the Appellants have clearly taught that the claimed features provide the unexpected result of "greater than expected" charge mobility. Consequently, it is clear that using ternary zinc-tin oxide as channel material was against the collective knowledge possessed by those of skill in the art. Thus, "mixtures of these oxides" and "compounds formed from these oxides" as recited in Cillessen would not have rendered ternary zinc-tin oxide an obvious choice for one of skill in the art among the hundreds of compounds and mixtures.

Under the analysis required by *Graham v. John Deere*, 383 U.S. 1 (1966) to support a rejection under § 103, the scope and content of the prior art must first be determined, followed by an assessment of the differences between the prior art and the claim at issue in *view of the ordinary skill in the art*. In the present case, the scope and content of the prior art, as evidenced by Cillessen, does not teach or suggest to one of ordinary skill in the art "a zinc-tin oxide compound having the following stoichiometry: Zn_2SnO_4 " or a "ternary compound containing zinc, tin, and oxygen stoichiometry: $(ZnO)_j(SnO_2)_{1-j}$, where j is between 0.05 and 0.95."

The differences between the cited prior art and the claimed subject matter are significant because ternary zinc-tin oxides used as channel layers provide unexpected electron mobility which results in superior performance as a channel layer in a transparent thin film transistor. Thus, the claimed subject matter provides features and advantages not known or

available in the cited prior art. Consequently, the cited prior art will not support a rejection of 4, 19, 48, 50, 60, and 64 and their dependent claims under 35 U.S.C. § 103 and *Graham*.

Claim 50:

Specifically addressing independent claim 50, which recites, *inter alia*, “a ternary compound containing zinc, tin and oxygen...having the following stoichiometry: **(ZnO)_j(SnO₂)_{1-j}, where j is between 0.05 and 0.95.**” This language is directed toward non-stoichiometric compounds that do not correspond to the law of definite proportions. The Action does not address these recited elements but simply asserts that Cillessen teaches “covalent oxide of a non-transition metal in terms of examples of eight such oxides.” (Action, p. 17). Cillessen is completely silent with respect to the possibility of creating non-stoichiometric compounds. To the contrary, Cillessen discloses only compounds corresponding to the law of definite proportions. Moreover, a compound having the “stoichiometry: (ZnO)_j(SnO₂)_{1-j}, where j is between 0.05 and 0.95” could not be created from the simple mixture of the eight binary compounds disclosed by Cillessen, because different proportions of the individual components must be combined to create the claimed non-stoichiometric ternary compound. Therefore, the compound (ZnO)_j(SnO₂)_{1-j}, where j is between 0.05 and 0.95, is not taught by Cillessen for at least the reasons set forth above.

(8) Claims 6, 11, 31 and 36 are patentable over Cillessen and Carcia.

Claims 6, 11, 31 and 36 were rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Cillessen and Carcia.

The features of independent claim 50, from which claims 6 and 11 depend, are neither taught nor suggested by Cillessen and Carcia, taken alone or in combination. Therefore, claims 6 and 11 are allowable over the cited art of record, at least, by virtue of their dependence upon allowable claim 50 for the reasons set forth herein.

The features of independent claim 60, from which claims 31 and 36 depend, are not taught or suggested by Cillessen and Carcia, as set forth above. Therefore, claims 31 and 36 are allowable over Cillessen and Carcia at least by virtue of their dependence upon allowable claim 60 for the reasons set forth above.

In view of the foregoing, it is submitted that the final rejection of the pending claims is improper and should not be sustained. Therefore, a reversal of the Rejection of January 10, 2008 is respectfully requested.

Respectfully submitted,

DATE: January 27, 2009

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VIII. CLAIMS APPENDIX

1-3. (cancelled).

4. (previously presented) A semiconductor device, comprising:

a source electrode;

a drain electrode;

a channel coupled to the source electrode and the drain electrode and comprised of a ternary compound containing zinc, tin and oxygen, where at least a portion of the channel is formed from a zinc-tin oxide compound having the following stoichiometry: Zn_2SnO_4 :and a gate electrode configured to permit application of an electric field to the channel.

5. (cancelled).

6. (previously presented) The semiconductor device of claim 50, where the zinc-tin oxide compound is substantially amorphous.

7. (previously presented) The semiconductor device of claim 50, where one or more of the source, drain, and gate electrodes is fabricated so as to be at least partially transparent.

8. (previously presented) The semiconductor device of claim 50, where the channel further includes phase-segregated ZnO.

9. (previously presented) The semiconductor device of claim 50, where the channel further includes phase-segregated SnO_2 .

10. (cancelled).

11. (previously presented) The semiconductor device of claim 50, where the channel is adapted to be deposited using an RF sputtering process.

12. (previously presented) The semiconductor device of claim 50, where the source electrode and the drain electrode are formed from an indium-tin oxide material, and are patterned so that the source electrode and drain electrode are physically separate from one another.

13. (cancelled).

14. (previously presented) The semiconductor device of claim 55, where the dielectric material is an aluminum-titanium oxide material.

15. (original) The semiconductor device of claim 14, where the dielectric material includes:

a first outer layer immediately adjacent to and in contact with the channel layer;

a second outer layer immediately adjacent to and in contact with the gate electrode,

where the first and second outer layers are each formed from Al_2O_3 and

alternating interior layers of AlO_x and TiO_y between the first and second outer layers, where x and y are positive nonzero values.

16-18. (cancelled).

19. (previously presented) A three-port semiconductor device, comprising:

a source electrode;

a drain electrode;

a gate electrode; and

means for providing a channel disposed between the source electrode and drain electrode, the means for providing a channel configured to permit movement of electric charge therethrough, between the source electrode and the gate electrode in response to a voltage applied at the gate electrode, the means for providing a channel formed at least in part from a ternary compound containing zinc, tin and oxygen, where the means for providing a channel includes means for providing a semiconductor formed from a zinc-tin oxide compound having the following stoichiometry: Zn_2SnO_4 .

20-25. (cancelled).

26. (previously presented) The thin-film transistor of claim 60, where the thin-film transistor is configured so that the ability of the channel layer to convey electric charge between the first and second electrodes in response to a potential difference applied across the first and second electrodes is dependent upon a gate voltage applied at the gate electrode.

27-30. (cancelled).

31. (previously presented) The thin-film transistor of claim 60 [[1]], where the zinc-tin oxide compound is substantially amorphous.

32. (previously presented) The thin-film transistor of claim 60 [[1]], where one or more of the source, drain, and gate electrodes is fabricated so as to be at least partially transparent.

33. (previously presented) The thin-film transistor of claim 60 [[1]], where the channel layer further includes phase-segregated ZnO.

34. (previously presented) The thin-film transistor of claim 60 [[1]], where the channel layer further includes phase-segregated SnO₂.

35. (previously presented) The thin-film transistor of claim 60, where one or more of the source, drain, and gate electrodes is fabricated so as to be at least partially transparent.

36. (previously presented) The thin-film transistor of claim 60, where the channel layer is adapted to be deposited using an RF sputtering process.

37. (previously presented) The thin-film transistor of claim 60, where the first and second electrodes are formed from an indium-tin oxide material, and are patterned so that the first and second electrodes are physically separate from one another.

38. (previously presented) The thin-film transistor of claim 60, where the dielectric material is an aluminum-titanium oxide material.

39. (original) The thin film transistor of claim 38, where the dielectric material includes:

a first outer layer immediately adjacent to and in contact with the channel layer;
a second outer layer immediately adjacent to and in contact with the gate electrode, where the first and second outer layers are each formed from Al_2O_3 and

alternating interior layers of AlO_x and TiO_y between the first and second outer layers, where x and y are positive nonzero values.

40-47. (cancelled).

48. (previously presented) A display, comprising:

a plurality of display elements configured to operate collectively to display images, where each of the display elements includes a semiconductor device configured to control light emitted by the display element, the semiconductor device including:

a source electrode;

a drain electrode;

a channel coupled to the source electrode and the drain electrode and comprised of a ternary compound containing zinc, tin and oxygen, where at least a portion of

the channel of the semiconductor device is formed from a zinc-tin oxide compound has the following stoichiometry: Zn_2SnO_4 and

a gate electrode configured to permit application of an electric field to the channel.

49. (cancelled).

50. (previously presented) A semiconductor device, comprising:

a source electrode;

a drain electrode;

a channel coupled to the source electrode and the drain electrode and comprised of a ternary compound containing zinc, tin, and oxygen having the stoichiometry: $(\text{ZnO})_j(\text{SnO}_2)_{1-j}$, where j is between 0.05 and 0.95; and

a gate electrode configured to permit application of an electric field to the channel.

51-53. (cancelled).

54. (previously presented) The semiconductor device of claim 50, where one or more of the source, drain, and gate electrodes is fabricated so as to be at least partially transparent.

55. (previously presented) The semiconductor device of claim 50, where the gate electrode is physically separated from the channel by a dielectric material.

56-59. (cancelled).

60. (previously presented) A thin-film transistor, comprising:

a gate electrode;

a channel layer formed from a zinc-tin oxide material having the stoichiometry:

Zn_2SnO_4 ;

a dielectric material disposed between and separating the gate electrode and the channel layer, and

first and second electrodes spaced from each other and disposed adjacent the channel layer on a side of the channel layer opposite the dielectric material, such that the channel layer is disposed between and electrically separates the first and second electrodes.

61-63. (cancelled).

64. (previously presented) A display, comprising:

a plurality of display elements configured to operate collectively to display images, where each of the display elements includes a semiconductor device configured to control light emitted by the display element, the semiconductor device including:

a source electrode;

a drain electrode;

a channel coupled to the source electrode and the drain electrode and comprised of a ternary compound containing zinc, tin and oxygen having the stoichiometry: Zn_2SnO_4 ; and

a gate electrode configured to permit application of an electric field to the channel.

65-67. (cancelled).

IX. Evidence Appendix

None

X. Related Proceedings Appendix

None

XI. Certificate of Service

None